STRATEGY RESEARCH PROJECT

DIGITAL C3 SYSTEMS ON THE MODERN BATTLEFIELD: TACTICAL SYSTEMS WITH STRATEGIC IMPLICATIONS FOR COMBINED OPERATIONS

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ABSTRACT

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The proliferation of digital technology is having a profound impact on how ground forces are equipped, trained, conduct operations, and most importantly communicate. The combination of sensors, smart munitions and digital communications systems will provide military commanders unmatched information clarity and ability to execute missions with unprecedented speed and agility. Many suggest the process of moving from Industrial Age Forces to Information Age Forces, is actually a Revolution in Military Affairs. The combination of technology and evolving security environment will create new challenges for interoperability, and operating demands on alliances such as NATO.

Several of NATO's members are aggressively developing digital command, control and communications (C3) systems. While NATO is currently pursuing initiatives to meet the interoperability requirements for systems interface, the scope of interoperability requirements will likely be beyond the mere passing of digits. The impact of digital C3 systems clearly affects interoperability across training, doctrine, communications and force structure. In order to ensure interoperability as new systems are fielded, NATO must initiate efforts now to ensure combined operations of the future are possible.

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The emergence of digital technology in the last decade has provided force designers the ability to expand the operating battlespace well beyond those planned for or anticipated in the Cold War environment.[1] The combination of sensors, "smart munitions" and digital communications systems provide the battlefield commander with the ability to make knowledge based decisions with unprecedented speed, and to execute them with equally unprecedented accuracy.[2] Implications for the conduct of combined and coalition operations range from forces enabled with systems providing the ability to conduct synchronized - high tempo operations to forces unable to simply communicate.

While there has always existed a disparity in modernization between and even among alliance partners, there arguably now exists the potential for such operational disparity as to jeopardize an alliance's basic ability to conduct combined operations. For ground forces, disparate national command, control and communication (C3) programs and modernization lies at the center of the problem. Current efforts to establish machine interface are showing promise, unfortunately the problem is greater than the challenge of merely passing digits.

In this paper I will review the emerging operational environment in NATO and will examine selected land maneuver C3 system modernization initiatives. While I will not evaluate C3 systems for merit ranking, I will examine their relative compatibility and subsequent effectiveness in a combined environment.[3] In addition, I will provide recommendations for decreasing the risk of incompatibility between national C3 systems and battlefield digitization in general.

PART I: THE NATURE OF ALLIANCES AND COMBINED OPERATIONS

An important distinction is necessary when discussing combined operations. Alliances and coalitions are not the same. An alliance is "the result of a more formal agreement (i.e. treaties) between two or more nations for broad long - term objectives which further the interests of the members"[4] A coalition on the other hand " is an ad hoc arrangement between two or more nations for common action."[5] The distinction is relevant in that considerations for interoperability apply to both, but often differently as the definitions suggest. Their terms are not interchangeable, but both terms are used in this paper.

Both alliances and coalitions require military forces to operate in a combined environment, and interestingly both alliance and coalition operations are part of contemporary and future NATO operations.[6] Interoperability is defined by both the NATO and JCS dictionary as "the ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use them to operate together."[7] JCS PUB 1-02 states that interoperability encompasses "the condition achieved among communications electronics equipment when information or services can be exchanged directly and satisfactorily between them and or their users."[8] It is interesting to note that interoperability, as a condition is more inclusive than weapons, logistics or communications. In fact the scope is defined as the requirement to achieve the highest level of rationalization (any action that increases effectiveness of allied forces through a more efficient or effective use of resources), standardization and interoperability.[9]

History shows us alliances and coalitions -- however difficult and exacting they maybe -- are essential organizations to the politics of states. Great efforts and resources have been applied to attain and to maintain them. The requirement for a nation to align with one or more other nations to achieve political or military objectives is a process, which is complex at best, and more often confusing to the casual observer. It is perhaps naive to believe that national interest and comradeship are synonymous when considering the basis for an alliance. Former United States President and Supreme Allied Commander in Europe during WW II, Dwight Eisenhower may have best described the often and controvertible nature of military alliances and coalitions:

> "History testifies to the ineptitude of coalitions in waging war. Allied failures have been so numerous and their inexcusable blunders so common that professional soldiers had long discounted the possibility of effective allied action unless available resources were so great as to assure victory by inundation. Even Napoleon's reputation as a brilliant military leader suffered when students in staff colleges come to realize that he fought against coalitions – there for against divided counsels and diverse political, economic and military interests."[10]

Yet in spite of their difficult nature, alliances have been essential elements in military operations since such operations were first recorded. Joshua and the Israelites fought the combined armies of Hittites, Amorites, Canaanites, Hivites and Jebusites around 1451 BC.[11] In Roman Times, alliances were essential for purposes of expanding and defending the empire. The ability to establish and maintain these alliances was of the result of the combination of " a common enemy, financial subsidization or threat of reprisal to a parent tribe or client state, promises of land and booty and even internal competition between Roman and allied units and their individual warriors."[12]

With the emergence of the modern nation state from the Middle Ages, conflict among the powers of Europe was a regular occurrence. The early modern empire of the Spanish Hapsburgs provides an illustration of allied interoperability of the age. "The Empire forces reflected the composition of society deriving from no less than six different nations, some even beyond the strict administrative boundaries of the Hapsburgs."[13] The key to avoiding divisive conflicts among multinational contingents was "the national contingents were maintained as separate administrative units."[14] This pattern of "separate administration" would become the norm for allied and coalition operations throughout the 20th Century. The major exception to this was the UN Force in Korea where US and Korean Divisions contained multiple battalions (and some cases brigades) from countries in Europe, Asia and South America.[15] The other significant change to this pattern is the contemporary composition of NATO and coalition peacekeeping forces deployed as part of the Stabilization Forces in Bosnia Herzegovina.[16]

Although the concepts of alliances and coalitions have developed over time, an enduring paradigm for assessing coalition operations is the "Four Pillars of Interoperability". They are *Training, Doctrine*, *Communication*, and *Compatible Structures*. NATO, has made great efforts since it inception to develop these Pillars.[17] And a brief review is instructive in considering the contemporary nature of NATO's interoperability, and also likely requirements for the future.

Training - Units must train as they fight. This essential principle is embedded in US doctrine and shared by NATO members and most allies. Until the end of the Cold War, NATO conducted regular large-scale exercises that provided great opportunities to develop the pillars of interoperability. Today, exercises continue but on a much smaller

scale and less frequently. The exercises most often use computer simulations, and are productive training events, especially for staffs and commanders. However, they cannot replace the opportunities afforded by large-scale exercises to establish interoperability techniques at the battalion through division level on the ground, in the mud. This change in the training environment suggests the challenge of preparing for combined operations is more difficult. A Key question facing NATO is how will technology in general, and specifically digitization of the battle field effect future training for combined operations?

Doctrine: Forces from different nations which plan (or anticipate) fighting together "must understand one another's doctrine, and doctrines cannot be too dissimilar."[18] However, any doctrine based primarily on technology is likely to fail. History is replete with examples, such as the French and their misguided belief in the infallibility of the Maginot Line to defend France from an invading force. NATO enjoyed a relatively similar doctrinal environment in the 1970s and 1980s. Although there were "NATO plans", there wasn't a "NATO doctrine" per se. Rather NATO members generally aligned with US doctrine. These war fighting doctrines for land battle were entitled "Active Defense", "Air Land Battle" and "Follow on Forces Attack."

Tactics used by different nations often differed but interoperability issues were resolved and solutions worked out during combined training events. Confronting NATO is the daunting task of ensuring doctrines do not become too dissimilar as technology changes not what ground forces do in the next twenty years, but how they do it.

Communications: The obvious requirement is for units that plan to operate (and fight) together must be able to communicate. Depending on the nature of the mission, different requirements will exist at different tactical levels. This entails not only

understanding what is said, but also the ability to physically communicate. The modern battlefield also brings the requirement for signals security, often in the face of a sophisticated enemy. Established alliances, such as NATO, have extensive systems in place to facilitate secure communications and operational security. Yet coalitions, particularly those that are diverse and have a high - low technical mix (as the case in DESERT SHIELD/DESERT STORM), will have to provide the means to bridge the gaps. This enduring challenge becomes more evident on the future battlefield as the basic contemporary digital radio illustrates.[19] The modern battlefield radio relies on changing frequencies based on a preprogrammed rate and sequence. This process makes interception, detection and jamming almost impossible. Radios among NATO members are different and compatibility among nations is an issue.

Compatible Structure: Units must be structurally similar in order to facilitate logistics and support operations. This doesn't mean units must mirror each other per se, but the more alike they are, the easier these functions will be.[20] For example, among the NATO member nations, no two forces are structured exactly alike, yet all have similar constructs, which are understood by member forces. Separate administration allows coalitions to focus on the basics of support and common understanding without having to address equipment and weapon interoperability at the lower echelons of operation, specifically below division or brigade. This, in turn, has allowed NATO to operate with differing structural compatibility.

NATO has made limited attempts at operating beyond separate administration. The Franco – German Brigade is one such example. Other elements are at the higher levels, such as different German Corps including a US or Dutch Division. These examples

have served the NATO of the cold War and the 1990s, but will they meet the requirements of 2020?

"Historically, the problems of the four pillars of interoperability have been solved primarily through trial and error during actual conduct of operations over an extended period of time."[21] In fact, it is the requirements born from practical necessity which dictate requirements in most coalitions. "Once established, a coalition normally requires coordination of effort to achieve common political, economic and social objectives; and of course unity of command. During W.W.II and the Korean War, these requirements were largely met. During the Vietnam War, they largely were not."[22] This dynamic continued as recently as the Gulf War.

During the Gulf War the coalition members relied on administrative organization to compensate for a wide range of interoperability problems; communication systems and language being key. The use of Soviet - built weapons systems by both coalition members and Iraq posed potentially devastating misidentification problems. Diverse levels of training also posed significant planning problems for coalition leaders. Communications problems were largely handled through the time honored use of Liaison Teams and administrative organization mitigated the risk and problems with organization, training and structure.[23]

Establishing a pattern of national contingents significantly minimized friction among different nationalities. With few exceptions, alliances would operate basically along these national lines in wars, conflicts and peacekeeping operations. By mitigating inter-alliance conflict through national administration, the requirements for interoperability were significantly minimized. The question of how feasible will this approach be in the

next 10 to 20 years is critical to the viability of NATO specifically and coalitions in general which are made up of Western postindustrial states.

The following can be considered true successes of NATO's interoperability initiatives: standard fuels (ironically the hardware to dispense the fuel is not standard), certain munitions, operational terms and graphics, and an integrated strategic and operational level command and control system are too few. Those that do exist serve to illustrate the complexity and difficulty creating true interoperability across the four pillars.

The NATO Handbook illustrates the continued relevance and importance of combined forces: "the organization of alliance forces ensures they remain fully capable of performing different functions which could be required of them what ever the situation - peace-crisis-war."[24] The NATO guide further states "the maintenance of an adequate military capability and clear preparedness to act collectively in the common defense therefore remains central to the alliance's security objectives."[25] We can therefore state that coalitions in the past have used the tools of language, training, doctrine to bridge the interoperability gap and liaison teams have been the underpinnings for this effort in combined operations.

How military forces address the articulated requirements for preparedness and ability to "act collectively" is framed by the changing security environment and the character of the alliance itself. To assess the impact of new technology on NATO member land forces, a review of the changing environment is required. Not only is the nature of international environment changing in regard to nation state interaction, but also the nature of the 21st Century battlefield.

PART II: CHANGING NATURE OF THE ENVIRONMENT

The potential for conflict has not diminished in spite of optimistic, post Cold War, projections to the contrary. Michael Mandelbaum points out that " Because of anarchy, no sovereign state can be entirely safe; any could be attacked; nothing prevents this."[26] This is the basis for the *realist's* view that "the structure of international politics has remained unchanged not only during the twentieth century but throughout the 25 or so centuries of recorded history prior to it; and that structure is the fundamental cause of war."[27] He further points out, however, that "the anarchy of the international system does not condemn its members to constant warfare; but all live with the possibility of, and therefore continuing preparations for war."[28]

An opposing theory suggests a process of "globalization" which promulgates a view "we are all becoming a part of an increasing homogenous global economy sharing the same cultural experiences and normative values, with international institutions available to sort out our differences."[29] Lawrence Freedman further suggests our "expectations with regard to the future of war are bound up with our expectations for the development of the international system as a whole and especially the degree of our optimism on whether this is turning into something resembling a world society." [30] But so as not to create any semblance of comfort in what might be considered in terms of world order, Freedman concedes that "to act as if force had no utility for us creates utility for our potential enemies. Unless we can be sure that war has become truly extinct we are tempted to hold on to our armed forces 'just in case."[31]

Is war really obsolete? Perhaps major war is obsolete.[32] But "not war in general - collective killing for some purpose-that is not obsolete, as the contents of the daily news

papers make clear."[33] Finally, the discerning thoughts of Carl Von Clauswitz provide a relevant and enduring perspective of viewing warfare:

> "Each period, therefore, would have held to its own theory of war, even if the urge had always and universally existed to work things out on scientific principals. It follows then that the events of every age must be judged in the light of its own peculiarities."[34]

Given then the theoretical viability of war and conflict, and the reality of daily events, what other aspects does the future security environment hold for NATO and the inherent requirement for interoperability? The nature of the future security environment is complex and diverse. Aspects of this future environment include "developments changing future war's nature; shifting regional alignments; development of security threats not limited to national boundaries or affiliations; the interagency character of assessing and responding to threats; weapon and military technology proliferation; and rapid change."[35]

Selected aspects of this view are articulated in a recently completed NATO study, entitled "Land Operations in the Year 2020 (LO 2020)." The NATO LO 2020 report provides a comprehensive view of what NATO expects to encounter in the first part of the 21st century. One key conclusion is the "character of war" in terms of its physical and moral demand on the fighting soldier is not likely to change.[36] But for all that may remain unchanged, it is what is expected to change which has the greatest potential impact on combined operations; the threat or security environment and the impact of technology on the battlefield.

LO2020 postulates that the future trend of operations for NATO will be expeditionary in nature and the anticipated *battlespace*[37] will be characterized by its unclear nature and lack of infrastructure (as compared to the cold war environment).[38]

LO2020 provides two views on the future threat. *View One* represents warfare between two modern, well equipped, well-trained mechanized forces. In comparison, *View Two* posits a modern force opposed by organizations that do not necessarily represent states nor structured in the manner of most armies.[39]

Seen as overarching both views is the sophistication and importance of *information warfare*.[40] Seen as one of the emerging characteristics of conflict in the 21st century, this form of warfare is expected to be orchestrated at the strategic level and will function primarily at the operational and tactical levels as information operations.[41]

What this view then suggests, is that NATO allies or a combined force containing NATO member forces, must be able to confront a vast array of potential operational requirements. A complex task for a single or Joint national force, much less a combined one.

How then to characterize the environment which exists outside of conventional warfare? No theory or pattern of conflict can positively identify what NATO can expect to encounter in the next 15 to 20 years. The complexity of the security environment cannot be overstated. Sufficient evidence suggests a broad requirement exists to maintain a conventional war capability and deal with existing and emerging threats. If there is little fundamental change in the nature of alliances, in so far as the nation state remains the principal actor in international relations, then it follows that coalitions will remain the premiere choice of alliances for using military force.

What then becomes the relevant dynamic effecting coalitions and combined operations? It is the environment in which coalitions will operate. Within the context of

the environment, there are two essential areas to consider; first is the nature of the threat (which has been discussed) and second; is the way in which operations will be conducted.

While the exact nature of the security environment may be difficult at best, or more realistically impossible to predict out to 2020, other trends, which directly effect how a NATO force will operate in a combined environment are somewhat easier to envision and predict. The specter of *Information Operations* (IO) permeates the current literature on future battle, and although is not the focus of this paper. Information operations are in a hierarchical sense, related to digital C3 on the battlefield.

Information Operations are defined by the recently published JCS "Joint Doctrine for Information Operation" (Joint Pub 3-13) as "actions taken to affect adversary information and information systems while defending one's own information systems. They apply across all phases of an operation, the range of military, and at every level of war."[42]

One need only briefly consider a recent event in the Balkans to see the potential of IO. A glimpse of one aspect of Information Operations as reported on April 1 1999 by the New York Times, NATO's World Wide Web site was "attacked by computer users in Serbia, using a 'ping attack' overloading the site's capacity to operate and rendering it nonfunctional."[43] The event was only one aspect of IO and illustrates the potential dynamic affect on the battlespace, and the larger context of how digitization is effecting warfare. While IO will be critical across the levels of war, it is the digitization at the operational and tactical level, which will have the greatest impact on how combined operations are conducted.

The modernization or digitization of land forces and the way in which NATO forces anticipate operating, have created a dynamic yet controversial culture of change. This collective process of change is frequently referred to as the *Revolution in Military Affairs*. There is no consensus on whether we are actually experiencing a Revolution in Military Affairs. Events and physical reality illustrate at least at a minimum, some sort of generation development exists. Contemporary journals are filled with theories and analysis on the subject. However, it is instructive for purposes of understanding the impact on combined operations and interoperability, to briefly review some of what is being written about RMA.

Alvin and Heidi Toffler discuss three waves in development of warfare; the agrarian, industrial and post industrial.[44] Author William Lind in his " The Changing Face of War: Into the Fourth Generation," proposes there are four. Perhaps one of the most compelling theories comes from retired Russian Major General Vladimir Slipchenko. General Slipchenko proposes that there are six generations of warfare; first defined by infantry and cavalry fighting without firearms, the second by gunpowder and smoothbore firearms, rifled small arms and tube artillery creating greater rates of fire and longer ranges define the third, the fourth generation includes automatic weapons, tanks, aircraft, enhanced transport capability and signal equipment, the fifth generation is defined by nuclear weapons and the sixth by superior data processing to support precision guided munitions.[45]

The lack of a universally accepted definition may facilitate debate, but this absence also frustrates the process of understanding and studying what is happening. There is however one proposed definition resulting from analysis done at the Center for Strategic

and International Studies (CSIS). This definition suggests the basis for RMA lies in a *military technical revolution*, and that what we're dealing with is "A fundamental advance in technology, doctrine or organization that renders existing methods of warfare obsolete."[46] There are obvious problems with a definition like this. Few if any are eager to embrace such a definitive and inclusive definition, yet it is useful in helping frame the ongoing debate and quest for signification. A temperance of this definition is offered in a view from George and Meredith Friedman who suggest that "a revolutionary weapon type does not, when first introduced, need have a effect in battle. In the case of the firearms, the impact did not even begin to emerge for two or more centuries."[47] The idea is insightful, but the continuing debate and the dynamics surrounding RMA are not readily reduced to insights, at least not yet.

There are those who like Williamson Murray, professor of history emeritus at The Ohio State University who suggest that in fact "we will confront multiple RMAs over the coming decades, a state of affairs somewhat analogous to events during the last significant interwar period: the 1920s and 1930s."[48] Murray goes on to point out quite appropriately that "we are at the beginning of an interwar period of indeterminate length. It may last another decade; it is just as likely to last fifty years."[49] In concert with Murray, Steven Canby points out "New Technologies will obviously change the techniques by which things are done in war, but they will change neither the nature of these things (e.g., gathering intelligence. Commanding, striking, protecting and moving about) nor the principles according to which these things are done..." [50]

And there are those who like Bill Lind caution against looking at technology in isolation as it "is a prescription for [the] failure to create a self-reinforcing tactical system,

or for the breakdown of an existing one."[51] In addition, "the term revolution should not be trivialized, and Lind did not believe there had been such a change in conventional war since the Second World War." [52]

With no clear definition of RMA, perhaps there is a clearer understanding of what is occurring in terms of digitization and the battlefield. An observation made in 1985 by Seymore Deitchman, then Vice –President for Programs at the Institute for Defense Analysis noted that;

> We are in the midst of a period of revolutionary change in the technology of the general purposes of military forces...over the next decade or two; those forces will be transformed radically in their doctrines, modes of operations, and capabilities.... The same technological advances that are making startling changes in the civilian world drive the revolution in military affairs. These advances include mainly, sensing, guidance, communication, and control of all manner of devices and machines."[53]

The issue of whether or not there is an ongoing revolution in military affairs may in fact not be the point. What *generation* of change we may be in or where a generation boundary is or isn't may not be that important as well, at least for the present. What is significant and relevant is that there is fundamental change taking place. This change is not only in the form of concepts but physical reality. Ongoing technological initiatives in the form of systems in the field today, unit structural changes driven by enhanced warfighting capabilities and doctrinal warfighting concepts (enabled by digital systems) in the US Army and other NATO members illustrate those changes. Changes that are all vivid indicators for the future and clear illustrations how the battlespace is changing today.[54] The overarching U.S. concept resulting from these changes is referred to as "*Full Spectrum Dominance.*"

The future battlefield as envisioned in *Joint Vision 2010* is one where established warfighting functions (maneuver, strike, protection and logistics) will yield to new operational concepts; dominant maneuver, precision engagement; full dimensional protection and focused logistics.[55] LO2020 provides for a similar vision of the future battlespace.[56]

Dominant maneuver will be " the multidimensional application of information, engagement, and mobility capabilities."[57] Key to dominant maneuver is the forces' ability to conduct sustained and synchronized operations from dispersed locations. This is a fundamental departure from the way in which analog units of NATO member nations have conducted operations in the 20th Century.[58]

Precision engagement "will consist of a system of systems that enables our forces to locate the objective target, provide responsive command and control, generate desired effect, assess our level of success and retain the flexibility to reengage with precision when required." The contemporary use of cruise missiles, space-based systems and laser guided munitions illustrate the capability provided by technology which will result in extended ranges and a greater ability to shape the battlespace.[59]

The ability to provide multi-layered protection of forces and facilities is the essence of full dimension protection. In addition "control of the battlespace to ensure our forces can maintain freedom of action during deployment, maneuver and engagement"[60], and the ability to degrade opportunities for the enemy enhance the survivability of our force.

Focused logistics is based on the "fusion of information, logistics and transportation technologies to provide rapid crisis response, to track and shift assets even while enroute and to deliver tailored logistics packages and sustainment directly at the

strategic, operational, and tactical level of operations.[61] Focused logistics will enable forces to operate at the expected higher level of tempo, with greater flexibility and dispersion. This is a radical departure from contemporary logistics and capabilities current analog systems can not provide.

Collectively these concepts rely on information provided by an array of systems, which is then transformed into a capability or process. Some of which are new; some are only emerging while still others are improved versions of contemporary analog systems. The combined effects then affords the digitally equipped forced with enhanced capability and significantly increased chances for mission success. The four concepts that collectively define *Full Spectrum Dominance* are expected to enable an appropriately equipped and trained force to successfully operate across the full range of military operations; ranging from humanitarian assistance, through peace operations and including the highest intensity conflict operations.[62]

The result is an environment that depicts forces operating with greater tempo and enhanced capability stemming from digital command and control systems, sensors and smart weapons. This concept mitigates the *information pathology*[63] dilemma, which has plagued commanders since the dawn of warfare. Additionally, the paradigm of the "empty battlefield"[64] may have attained another dramatic step. An interesting consequences of digital systems is how they enable or cause continued expansion of the battlespace, and at the same time, may facilitate what Du Pique (as well as others such as S.L.A. Marshal) referred to as "principal of mutual proximity". That is the need to have proximity of one's fellow soldiers – friendly units. Figure 2 illustrates how empty the battlefield has become in this century, and the dramatic effect digital systems have on expanding the battlefield.

What is clear is the future battlefield, enabled with digital technology has the potential to become even "emptier". Battle will of course still be influenced by elements such as terrain, weather and the enemy. Nonlinear operations will be the norm, with units providing mutual support through sensors and munitions in the absence of the physical proximity required in twentieth century operations. This dynamic has significant implications for allies and their ability to conduct combined operations.

While there is no way to definitively predict how forces will operate in 2020, we do have available early indications what some of the characteristics will be. The envisioned impact of digitization on the battlefield is more than theoretical as demonstrated in recent advanced warfighting experiments by the US Army. Key emerging insights and lesson learned on how these systems will effect the digital battlefield are being studied and applied today. Specifically, lessons learned from the 1997 Division Advanced Warfighting Experiment (DAWE) are proving to be most discerning and instructive.

The DAWE was designed to test a number of hypotheses to include among other things; the training, use and effectiveness of selected digital systems.[65] Critical lessons were learned regarding the impact of information dominance and the process of battle command on the digital battlefield. The ability to process sensor data into intelligence by the Analysis Control Team (ACT) at the brigade level and the Analysis and Control Element (ACE) at the division level significantly enhanced the commander's knowledge of the enemy.

Division XXI Battlefield

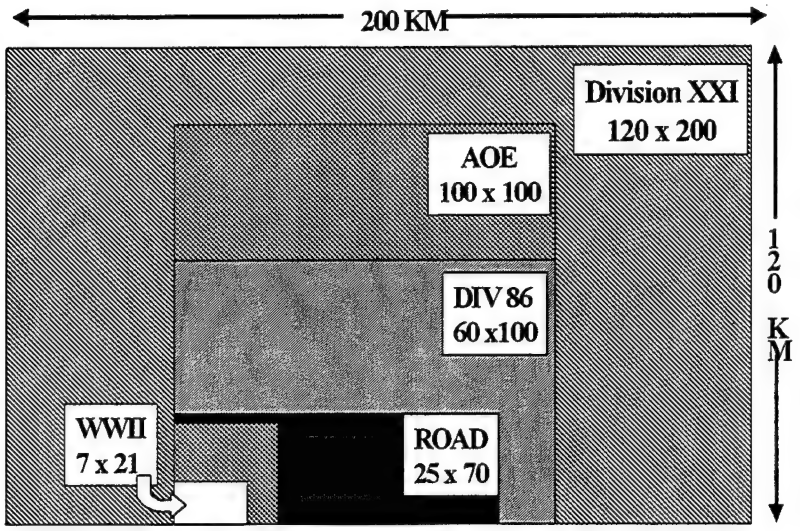

Figure 2, "The Expanding Battlefield"[66]

The combined affects of the Force XXI division organization, operational concepts and digital systems are the essential ingredient in providing the commander the relevant common picture of the battle space.[67] Equally compelling is the impact on battle command capabilities.

> "Army Battle Command System (ABCS), coupled with near – real time information, enabled the division staff to provide the commander with a situational update in less than an hour that routinely took over six hours in an analog division. ABCS enabled the commander and staff to prepare and disseminate orders in a timely, accurate way which is not possible in non-digitized units, to quickly cross attach units in the midst of battle, and to conduct distributed operations across the expanded battlespace."[68]

The development and fielding of digital command and control systems, which enable information dominance and facilitate battle command, will no doubt have a

profound impact on the ability to conduct combined operations. The scope of *Full Dimension Operations* is changing the way operations are being conducted today (the use of UAVs and precision munitions in Kosovo is but one example) and will effect change well into the next century. The analogy of a three dimensional chess game may provide a clearer picture of how the future battlefield is envisioned. It is one where opponents may "see" most if not all of each other's pieces. But the side better equipped and skilled in the use of digital systems and advanced technologies, is able to execute moves of greater surprise, speed and consequence as to render the enemy unable or unwilling to proceed.

The impact of these changes, however revolutionary or evolutionary, will greatly effect how military operations are conducted in the next ten to twenty years. How then are NATO members, allies and other potential coalition partners approaching the requirement to digitize the battlefield? A comparison of selected digital C3 systems will provide insight into potential impact on the four pillars of interoperability, and NATO's future ability to conduct combined operations.

PART III: THE NEW TECHNOLOGY

There are various technologies, which show potential for military application in the next ten to twenty years. They range from "off the shelf" commercial computer and electronic systems, lasers, improved legacy systems currently in use, non-lethal incapacitating devices to futuristic biotechnology systems.[69] The ongoing process of digitizing the battlefield, now suggests there is a fifth pillar of successful coalition operations. The fifth pillar is technological interoperability. At the heart of the digital technologies envisioned for use on the battlefield are those systems, which provide for C3

and SA. A brief look at selected systems and a subsequent comparison will assist with understanding the scope of ongoing initiatives. By reviewing what is in use now as well as emerging and planned systems, an assessment of interoperability and the potential impact on the conduct of combined operations is possible.

At the operational level NATO currently relies on a system called *CHRONOS*. This system includes, graphics, messaging, email, MS office on one machine. CHRONOS enables NATO to operate (when assets are pushed down to division level) from the division level to SHAPE Headquarters by satellites owned by NATO. The benefit for combined operations is obvious, a secure – common communication system with command and control capabilities (including VTC). CHRONOS is essential for interoperability since it enables NATO to communicate and facilitates C3 at echelons from division and above.[70] CHRONOS is currently in use with NATO forces operating in Bosnia.[71] This system is fixed base and not designed to be used by mobile operational or tactical formations. This is a legacy system and does not contain the capabilities found in emerging systems.

To conduct *Full Dimension Operations* at the division, brigade and battalion levels, systems must be able to provide not only C3 and SA, but perhaps most important, a common relevant picture, resulting in a common understanding of what is going on. This understanding includes both friendly and enemy information. In addition, the ability to use these systems to facilitate the next mission or series of actions while conducting the current mission (s) may arguably be as important as providing the relevant common operational picture. The ability to share this across the combined force is essential. While there are literally hundreds if not thousands of engineering and design requirements

for systems such as these, a discussion of a select number of characteristics or capabilities, which indicate the level of interoperability a specific system may have is useful.

The following subsets of hardware and software descriptions are samplings of what is going into C3 and SA systems. This description is not inclusive but rather illustrative of on going efforts and common requirements, and is not intended to be a tutorial on operational architecture and engineering. Additionally the intent here is to provide a relative comparison from which a sensing of interoperability can be made.

Each system must be able to physically communicate. This is accomplished (at the lowest tactical level) through the use of wide band digital FM radio communications. Radios capable of carrying voice and data transmissions. Additionally many countries use a tactical line of sight system relying on microwave transmissions. Systems in use or planned will use a combination of both and operate a systems architecture in what is called Asynchronous Transfer Mode (ATM).[72] ATM allows for voice and data transmissions to occur within the same system. In most cases this combination of systems creates what is referred to as a tactical Internet, similar in concept to the commercial one most people are familiar with. The addition of satellite communications to interface with higher echelon systems and other non-defense agencies are also a part of this expanded system.

The second requirement is to pass information or data. Current systems rely on fixed format messaging to accomplish this. In the past our common data was a common operational "voice" language based on terms and graphics. Any ambiguity was readily resolved using the "human interpreter". Machines are not as accommodating when dealing with ambiguity. Because of this interpretation dilemma, terms for units for

example must match or an interpreter (presently human) capable of matching like size units using unit terms with different national meanings.[73]

Although data and digits have been passed for some time, what is changing is that emerging systems not only carry voice but the ever-increasing volume of digitally encoded data. Data which is not only the message part of C3 (there is much more to C3 than just messages) but also data which is friendly and enemy unit locations (the SA) displayed on screens. The ATM architecture is an essential element of a system's ability to accomplish the data delivery requirements.

Applications range in function from familiar programs found in office automation tools (common software for word processing, spreadsheets etc) to the more exotic applications such as collaborative planning systems (such as *white boards*,[74] Video Teleconferencing) and automated *course of action* [75]development tools. These applications are not central to digital C3 per se, but provide for expanded capability and enable commanders and staff to fully exploit many of the advanced digitization technologies such as sensors and munitions.

The following profile of selected NATO member initiatives is a short review designed to illustrate how certain NATO members are addressing the requirement of communication, data transfer and applications through fielding of tactical digital C3 systems.

US ARMY - The central tactical U.S. Army system is Force XXI Battle Command – Brigade and Below (FBCB2). The system has embedded battle command software integrated into various platforms down to and including selected fighting platforms. Additionally, as a component of FBCB2 the Embedded Battle Command software will be

positioned at selected sites at Division and Corps levels to support operations as necessary, and on tactical operations center servers at brigade and below. The core command and control system is the Maneuver Control System (MCS). Additionally, Intelligence, Fire Support, ADA and Logistic systems operate with FBCB2 to create the Army Battle Command System (ABCS). U.S. plans call for transforming ABCS from a "shared message" system to a "shared database" called the Joint Common Database by 2001.[76] Above FBCB2 and ABCS is GCCS –A which is tied into a Joint system - GCCS. In effect what occurs is a tie-in from the strategic level to the tactical level.

FBCB2 communications are facilitated via a tactical-communications infrastructure entitled Warrior Information Network – Terrestrial (WIN-T). The system uses SINGARS –ASIP radios and the Enhanced Position Location Reporting System (EPLRS) which collectively form the Lower Tactical Internet. The Near Term Data Radio (NTDR) and the Multiple Subscriber Equipment (MSE) form what is referred to as the Upper Tactical Internet.[77] Central to interoperability is FBCB2's ability to assign and release units (task organize) within the combat formation. The ability to accomplish this with U.S. units is planned, and will be demonstrated during the FBCB2 Force Development Test and Experiment event in April 2000.[78] It is not clear if this capability will exist for allied or coalition units.

Collaborative planning tools such as video teleconferencing, interactive "white board" capability and automated COA development tools are also planned. The U.S. Army is also fielding an active "combat identification" system for combat platforms know as Battle Command and Identification System (BCIS). Plans call for the first digital division to be fielded in 00, the second in 03 and the Digital Corps by 04.

CANADIAN LAND FORCES - The Canadian System is Land Forces Command System (LFCS). This system will have two major components; LFCS at the brigade to division/Corps level and Situational Awareness Software (SAS) from the brigade to platoon /vehicle level. The tactical communication network (digital radios and LOS communications network) is entitled *IRIS*. At this time it is envisioned that only selected vehicles will be equipped with the SAS components. Embedded battle command and SA capability are intregal to this system. The planned Canadian system is based on the French System of Information for Command of Forces (SIC-F) command and control software. Above LFC2IS is the joint J2CIS system. One interesting aspect of the Canadian system is it will be the same system used in garrison as well as in the field during operations and deployments. Also, unlike other initiatives the Canadian plan is to field a truly Joint system from the outset. LFCS/SAS will have the ability to task organize Canadian units, and coalition units with in the command and control systems. However, presently there is no plan to accept allied or coalition elements (at the individual vehicle level) within the SAS SA architecture.

While there are plans for VTC capability from division and brigade command posts, there are no current plans for a white board or automated COA development tool. There is no plan for an active vehicle identification system. The Canadian system will rely on the US GPS system. Current plans call for a baseline system running in 1999, incremental fielding of both SAS and LFCS down to Battle Group (battalion/task force) for deployed and garrison operations by 2001. Continued enhancements and fielding continue out to and beyond 2003.[79]

BRITISH ARMY - The tactical UK system about to enter service is referred to as the Battle Command and Information System (BCIS) and Battlefield Management System (BMS). This system will rely on a tactical Internet using voice and digital FM communications entitled BOWMAN. BOWMAN will incorporate other systems such as the PTARMIGAN (LOS) system to create a tactical communication network for brigade and below. Capabilities include software supporting battlefield information as well as a battlefield management. The system at present is envisioned to be employed down to selected platform level and some dismounted infantry as well by 2002 time frame.

At the operational level, the British rely on the Enhanced Interim ACE Rapid Reaction Corps Information System (EIARRCIS) for secure communications, office automation and selected planning tools down to brigade level. The replacement for this will be Formation Battle Management System (FMBS). FMBS will be the linkage system to BMS. There is no current plan for the UK system to accept coalition system SA input at the vehicle/platform level, but will accept coalition units within the battle management framework. The UK system will have an automatically positioning capability on the GPS system. Additionally, there is no fielding of an UK identification system currently planned.[80]

The UK and US are collaborating on the design of the Future Scout and Cavalry System (FSCS), and it is expected these systems will be interoperable.[81] In addition the U.S. and UK have an ongoing initiative to develop a coalition *operational architecture* enabling a digitized British Division to operate with a US digitized Corps.

FRENCH ARMY - The French system will have three integrated components or subsystems. Division to brigade system is entitled; "System d'Information et de

Commandement des Forces" or SIC-F. The next level is brigade to company and is called "Systeme d'Information Regimetaire" or SIR. The lower level system (which is still on the drawing board) is titled "System d'Information Terminal" or SIT. It is envisioned this system will facilitate platoon to company C3. The French use the PRG4 digital radio (voice and digital capable) and the RITA tactical communications system to create a tactical internet. This system will accommodate task organization changes with in the C3 framework but it is unclear if it will accept individual allied vehicle systems into SA. The French are planning to field an active identification system similar to the US Army BCIS. A test version of SICF is currently in use with French Forces in Bosnia. The first brigade to be fielded with SIR is expected in 2002. [82]

GERMAN ARMY - The German system is entitled HEROS. For communications the German system relies on AUTOKO 90 (digital wide area network), BIGSTAF (broad band integrated command post communications system – LAN) and the SEM family of digital radios to create its tactical internet. The system will provide command and control software and situational awareness capability. Like the other systems mentioned, HEROS is not envisioned to be able to accept SA from other allied systems at the individual vehicle/platform level, but will within the battle management function. The Germans plan to achieve the main command and control functions by 2003/2004. There is no identification system currently planned.[83]

These system profiles serve to illustrate the scope of ongoing initiatives by selected NATO members. In each case there is a thread of interoperability in that systems are similar in configuration, roughly similar force structure alignment (a tactical system and a system to operate at the operational level) and all rely on a tactical internet composed of

large bandwidth digital radios and a line-of-sight tactical communication system. Some are clearly more developed in terms of software and hardware, and timelines for fielding vary. Certain systems shown encompass distribution of components from individual platform to echelons above Corps, others as presently envisioned, do not.

This illustration shows that there is a significant lack of commonality among the digital command and control programs. Current NATO standards under which members are operating are not sufficient to establish interoperability among these new systems.

In the NATO Interoperability Planning Document (NIPD), two key levels of system interoperability are defined, Level 4 and Level 5. Level 4 is the ability to pass pre-formatted messages from one system to another. Level 5 is where systems have the ability to conduct database to database updates using a data replication mechanism. Level 4 interoperability function is occurring now. Level 5, once achieved, will signal true interoperability in that dissimilar national systems will, through a data gateway, operate in a common operating environment. In essence, the machines will share information, and perhaps more importantly, be able to deal with the ambiguity of one national system to another in a similar fashion done today through voice communications and LNOs. Fortunately, NATO members are aggressively pursuing the Level 5 objective through two ongoing programs; the Multilateral Interoperability Program (MIP) and Army Tactical C2 Information System (ATCCIS).[84]

NATO has numerous committees and working groups established to find solutions to problems facing NATO and its ability to function as an alliance. Within the NATO Army Armament Group, NATO Land Group 1 is actively engaged in working with both the MIP[85] and ATCCIS groups. Although not technically NATO initiatives, input from

Land Group 1 through a series of decision documents have helped shape the objectives in earlier experiments such as the Battlefield Interoperability Program (BIP)[86], and other key initiatives such as MIP/QIP and ATCCS.[87] The good news is efforts such as these are on track to establish a functional means by which disparate national C3 systems will be able to interface, in real time and with the fidelity necessary to conduct *Full Dimension Operations*.

Unfortunately in the shadow of glowing optimism created by the power and capability generated by these emerging systems, potential problems exists. There are a number of disconnects in areas of doctrine, tactics, methods of fielding, timing, and resource allocation. These disconnects pose significant problems within the NATO alliance or potential coalitions. Collectively these issues or disconnects can be considered as *digital deadspace*.[88]

The question of interoperability with digital radios maybe only one example of a communications disconnect. Even so, it illustrates a key lack of technical cooperation among allies. Operationally this type of incompatibility could prove devastating if, for example, units "out run" their tactical internet as they did in Dessert Storm, and have to rely on FM radios to carry digital traffic, the resulting problems are obvious.[89] Potential for problems in less mobile situations, such as peace keeping operations exists when one considers the possibility that many countries participating may only be able to afford to field portions of the C3 SA systems coming online, thereby rendering themselves vulnerable to aspects of digital deadspace.

The advent of Level 5 data compatibility is essential to interoperability for different national C3 systems. There are, however, other areas where data and SA disconnects

pose significant threats to combined operations. The Battlefield Combat Identification System (BCIS) system is one such example. The U.S. Army plans to field around 1200 of the systems over the next three years at a cost of around $35 million.[90] It is difficult to find fault with a system designed to reduce the probability of fratricide by providing a reliable means of identifying friendly vehicles beyond visual recognition range or in limited visibility conditions. However from a combined environment perspective, the potential for interoperability problems are apparent. Mixing fleets of vehicles at the battalion or brigade level would cause confusion at the very least, and likely render the system ineffective or marginally functional at best. Condition such as this would likely cause the resurgence of the old coalition standby, administrative organization, in an attempt to remedy the problem.

Applications ranging from the off the shelf office software to the exotic collaborative planning tools will be a critical element in planning and execution of operations in the next ten to twenty years. The impact on a division's ability to conduct *Full Dimension Operations* has already been discussed. Imagine a division equipped and versed in the use of these systems combined with a force (brigade or battalion) not equally equipped or skilled in their use. The inability to operate in a synchronized fashion would not only degrade the overall capability of the larger force, but also likely increase the risk of mission failure and weaken force protection.

The previously mentioned illustrations serve to show the significance of the fifth pillar of combined operations, and the potential impact of digital deadspace on the conduct of combined operations. There are certainly other such examples when one considers the inclusion of air and naval systems as well.

PART IV: IMPLICATIONS FOR NATO AND COMBINED OPERATIONS

There is a minefield of potential issues, which could, if not adequately addressed, imperil NATO interoperability. The significance of the fifth pillar on combined operations will only grow as systems are fielded and the use of these systems becomes normative for some but not all. The following issue areas highlight potential impediments for interoperability resulting from the dynamic of digital deadspace. The list is not inclusive nor is it designed to explore the specific scope of each implication mentioned. Rather the list is provided to help frame the larger context and implications of digital deadspace.

The United States is clearly leading NATO members in the process of digitization. US Secretary of Defense William Cohen recently commented during congressional testimony that he was concerned about the "increasing technological gap' between the US and NATO allies. Secretary Cohen stated he had commented to select allies that less defense spending [on technology development] on their part would only create greater risk for NATO's ability to conduct combined operations.[91] Without a deliberate approach to dealing with the disparity, NATO runs the risk of resurfacing the contemporary version. of the cold war burden sharing issue.[92]

There has always been a high – low mix of forces with NATO (and with in any given Nation at a given point in time). It is not simply who has a howitzer that can shoot farther, the fastest fighter or a tank with thermal sights versus another without (these types of differences are not insignificant but they can be resolved). Rather what will occur is a situation where capabilities are so disparate, that different members may be driven to unwise decisions concerning expenditures or procurement. Decisions driven by fear of not

wanting to get behind, considered to be less than a full partner or be relegated to a suboptimal (militarily or politically) role.

Doctrinal considerations must deal with the application for new technologies. How each NATO member individually deals with the implications of battle command and the flow of information must be reconciled. The flattening of information hierarchy with information being available to the lowest levels and the decentralization of decision making has profound functional and cultural implications on warfighting and interoperability. How each nation translates this into the application of doctrine through tactics, techniques and procedures is key to the future of successful combined operations.

Training implications focus on the ability to interoperate in the domain of simulations. The US has two ongoing simulation programs, which will likely meet most force development and training requirements. OSD Joint Warfare Simulation (JWARS) and Army's Warfighter 2000 (WARSIM). Neither system is currently designed to directly support operations or the developing automated decision support tools.[93] Reliance on simulations will only increase and the training pillar of interoperability will require a system(s) to enable allies and coalition partners to train in a combined environment.

Structural considerations must include changes resulting from digitization efforts. The US has already begun reconfiguring its heavy divisions based on capabilities attained (and anticipated) through digitization.[94] In addition to structural changes, processes are changing as well. A key example is logistics. Where NATO logistics have been largely a national responsibility in the past, the ability to effectively "plug" an analog unit into a digitally managed logistics system is highly unlikely, providing one more aspect of digital deadspace.

Other structural redesign initiatives are well underway for light forces. New organizations such as the US Army's rapid deployment "Strike Force"[95] initiative must be evaluated and assessments made regarding the impact on interoperability. The implication for NATO's Combined Joint Task Force and other operational initiatives incorporating varied force structures (such as partnership for peace operations) must also be evaluated.

Most NATO members have decreased defense spending during the 1990s, and continue with defense budget declines. More illustrative of the problem is the NATO average (minus U.S. and France) for percent of defense budget for capitol investment has dropped from nearly 21% to just below 18% for the same period.[96] Competition for scarce budget share by big-ticket systems such as aircraft and ships has squeezed the capitol available for critical digital systems, having the obvious impact on battlefield interoperability.

In spite of declining defense expenditures in general, and specific allocations for C3, there is the potential for an arms race among allies. Competition for market share of emerging systems for C3 and SA can create the environment where cooperation is based on protecting national industries over allied interoperability. Fierce competition has existed for years in a number of defense industries (fixed wing and rotary wing aircraft, support vehicles, air defense systems, etc.). Greater cooperation is needed to cover the digital deadspace, not less.

PART V: CONCLUSION

In an era of global communications evidenced by the world wide web, standardization and interoperability in the commercial sector are driven by market

requirements. National security and industry proprietary concerns may influence digital interoperability on the battlefield. The five pillars of interoperability remain key to the successful conduct of coalition operations. Likewise with the digitization of the battlefield, the fifth pillar, technical interoperability becomes essential to successful combined operations.

The ability to cover the digital dead space envisioned in combined operations, with the enablers of the past; current doctrine, common terms and graphics, language (new challenges exist with the introduction of new members) underpinned by liaison teams will no longer suffice in the year 2010. The digital dead space created by the disparity in C3 systems, mixed fleets of combat platforms and support vehicles, subsequent doctrinal incongruity and disparate operational capability will at best strain operations creating additional friction. Friction is a condition where more is not better, and possibly worse, create conditions rendering infeasible the conduct of combined operations.

NATO must take steps to fully address the processes for ensuring interoperability of C3 and SA systems. There is the strong possibility that digitization, with all its capability and potential on the battlefield will create conditions leading to the dilemma where NATO forces are unable to function properly, efficiently or effectively in a combined environment. As we embark on the information age battlefield, the challenge to leaders and soldiers who conduct the range of operations from peace keeping to fighting wars is to understand the impact on the conduct of operations and possibilities digitization provides. This in turn has a profound impact on coalition and combined operations, operations that have never been easy and may become more, not less difficult in the future.

PART VI: RECOMMENDATIONS:

What follows are recommendations for mitigating the impact of digitization within the alliance and coalitions.

- The United States should include selected Allies in the experimentation and Advanced Warfighting Experimental process. This means more than observer status and participation in selective exercises. Canada for example provides a logical choice given we're close doctrinally, a history of mutual defense, and a formal defense treaty predating NATO. A partnership with the Strike Force initiative is a logical choice. Concerns with copyright laws and patents must be resolved, as there are obvious concerns over proprietary considerations. Resolution over security classification disconnects must also be resolved.

- The process of communications is more than passing digits, and verbal communications are still essential to effective combined operations. An automated language translator must be developed and employed. The language translating tools exist now for text. It is amazing we can go to the moon, design a missile defense, build an international space station and transplant limbs but not field an affordable automated tool as critical as this.

- The U.S. should consider increasing or reapportioning of some of its Foreign Military Sales (FMS) credits to include new NATO members, and specifically designate the fund for digital systems at division and below. NATO should develop a 'pairing" system whereby a member with a developed system sponsors one without a digital C3 system. This will mitigate the burdensharing issue and help ensure no one is left behind.

- Training facilities such as the digital training facility at Ft. Leavenworth must be made available to enable allied staff officers to train on digital systems. Distance learning techniques will also help standardize training. NATO should begin the process of establishing a school facility now along the lines of the NATO defense college, or the Marshal Center at Garmisch to instruct on the use of Digital C3 systems, and coordinate doctrine development for use among NATO members. A combined simulation capability is essential. Without such a capability, the inability to train in a combined environment will preclude developing the ability to operate across the pillars of interoperability.

- Doctrinal warfighting concepts for the use of Digital C3 systems must be developed sooner not later. Procedures for integrating digital and non-digital units are a key priority. Members with C3 systems could take responsibility for development of different aspects of required doctrine. More than likely there will not be sufficient time to sort things out on the ground after a mission is underway. The nature of the future battlespace and the degree of change that combined operations will experience, suggests the old methods of compensating for the lack of interoperability will not work.

ENDNOTES

[1] The concept of the empty battlefield is discussed in the "Changing Environment section" and a graphic illustration is provided in Figure 1.
[2] The "Future Battle Space" as described in JV 2010 and the US Army's version "Army 2010", detail an environment where multinational operations will be the norm. Additionally, future warfighting enabled by new technologies, specifically digital C3 systems, will facilitate four operational concepts; dominant maneuver, precision engagement, full dimension protection and focused logistics.
[3] The scope of command, control and communications systems undergoing modernization and digitization encompasses all services and is extensive. By limiting the review to land forces, an assessment of interoperability and implication for combined operations can be made.
[4] Joint Chiefs of Staff, Joint Publication 1-02, *Department of Defense Dictionary for Military and Associated Terms*, 23 march 1994, as amended through 10 February 1999: 42.
[5] Ibid., 77.
[6] NATO's current command system is the recently adopted integrated Military command structure. Current missions include Partnership for Peace exercises, SFOR mission and operations in Kosovo and Yugoslavia. All illustrate the scope of coalition operations NATO is involved in. These operations also indicate those types of environments NATO members will operate in the next ten to twenty years.
[7] Joint Pub 1-02, 128.
[8] Ibid.
[9] Field Manual 100-8 *The Army in Multinational Operations*, Headquarters, Department of the Army, November 1997: 2-15.
[10] Dwight D. Eisenhower, *Crusade In Europe*, (New York: Doubleday and CO, 1948), 4.
[11] Joshua. 9. NIV (New International Version).
[12] Benjamin Franklin Cooling and LTC John A Hixon, "Interoperability of Allied Forces in Europe: some Historical Peacetime Realities, Part 1," *Military Review* (August 1978): p.64
[13] Ibid., 65.
[14] Ibid., 66.
[15] For an excellent accounting see Clay Blair's, *The Forgotten War, America in Korea 1950 - 1953*, (New York: Double Day, 1987) or Matthew B. Ridgeway, *The Korean War*, (New York: Da Capo, 1967).
[16] SFOR - NATO forces are divided into three major sectors. The US sector alone is comprised of no less than eleven nations, with contingents composed of platoon to brigade size forces, some with division level command and control as well as support elements.
[17] Brigadier General William J Mullen III and Lieutenant Colonel George A Higgens, US Army, "Four Pillars of Interoperability", *Military Review*, January 1992.

[18] Ibid., 47.
[19] Marc Michaelis, LTC, US Army, "The Importance of Communicating in Coalition Warfare," *Military Review* (November 1992): 42-48.
[20] Ibid., 47-48.
[21] FM 100-8, The Army in Multinational Operations, 2-16.
[22] Wayne A Silkett, "Alliance and Coalition Warfare," *Parameters* (Summer 1993): 78.
[23] Brigadier General Robert Scales, Jr., US Army, *Certain Victory: The United States Army in the Gulf War*, Office Of The Chief Of Staff United States Army, Washington, D.C., 1993.
[24] North Atlantic Treaty Organization, *The NATO Handbook: Online Version*, October 1995, Part III: Organization and Structure. Available at http://www.vm.ee/nato/docu/handbook/hbl1060le.htm, 5 April, 1999.
[25] Ibid.
[26] Michael Mandlebaum, "Is Major War Obsolete?" *Survival* 40, no. 4 (Winter 1998): 26.
[27] Ibid.
[28] Ibid.
[29] Lawrence Freedman, "Military power and political influence", *International Affairs*, no. 4 (October 1998): 764.
[30] Ibid.
[31] Ibid.
[32] Michael Mendlebaum defines "Major War" by providing examples from the last 200 years: The French Revolution (1792-1815); the First World War (1914-1918); the Second World War (1939-1945); and the Cold War (late 1940s-early 1990s). He further suggests this list is "numerically small but historically monumental class of wars to which these four conflicts all belong that is obsolete."
[33] Mandlebaum, "Is Major War Obsolete?" 20.
[34] Carl Von Clauswitz, *On War*, edited and translated By Michael Howard and Peter Peret, (NJ: Princeton University Press 1984), 593.
[35] Graham H. Turbiville Jr.; Colonel William W. Mendel, US Army, Retired; and Jacob W. Kipp, "The Changing Security Environment," *Military Review*, (May -June 1997): 1.
[36] NATO Long-Term Scientific Study (LTSS/49) on Land Operations in the Year 2020 (*LO2020*), Final report (November 1998), annex I, 45.
[37] The report makes a very important distinction between battlefield and battlespace. The report defines "battlespace is a physical volume, which includes the moral dimension that expands or contracts in relation to the ability to acquire and engage the enemy. It includes the breadth, depth and height in which the commander positions and moves his assets over time. Battlespace is not assigned by a higher commander and extends beyond the commander's area of operation.", 48.
[38] LO2020., 40.
[39] Ibid.
[40] Information Warfare is defined in JCS PUB 1-02. Also see, Alvin and Hedi Tofler, *War and Anti War - Survival at the Dawn of the 21st Century*,. Little Brown and Company, 1993.
[41] LO2020., 47.

[42] Joint Chiefs of Staff, Joint Publication 3-13, *Joint Doctrine for Information Operations*, 9 October 1998. Executive Summary,: 1.
[43] Amy Harmy, "Serbs Revenge: NATO Website Zapped," *New York Times*, April 1, 1999, sec. 1A, p. 1.
[44] Alvin Toffler and Heidi Toffler, *War and Anti-War: Survival at the Dawn of the 21st Century*, (New York: Little, Brown & Company, 1993) referenced in LCDR Randall G. Bowdish, US Navy, "The Revolution in Military Affairs: The Sixth Generation," *Military Review*, (November-December 1995): 26.
[45] MG Vladimir Slipchenko, "A Russian Analysis of Warfare Leading to the Sixth Generation," *Field Artillery* (October 1993): 2-11, quoted in Bowdish, "The Revolution in Military Affairs: The Sixth Generation," 26.
[46] Michael Mazarr, et al., *The Military Technical Revolution: A structural Framework*, Washington ,DC: Center for Strategic and International Studies, (March 1993), 13, quoted in Bowdish, "The Revolution in military Affairs: The sixth Generation," 27.
[47] George Friedman and Meredith Friedman, *The Future Of War Power, Technology And American World Dominance In The Twenty First Century* (New York: St Martin's Griffin, 1998) 119.
[48] Williamson Murray, "The 1996 RMA Essay Contest," *Joint Forces Quarterly* (Spring 1997): 6.
[49] Ibid., 7.
[50] Steven Canby, "New Conventional Force Technology and the NATO-Warsaw Pact Balance: Part I" in *New Technology and Western Security*, Part II, 7. Quoted in Lawrence Freedman, "The Revolution in Strategic Affairs," *Adephi Paper*, no. 318 (1998).
[51] Freedman., 22.
[52] Ibid.
[53] Seymour Deitchman, "Weapons, Platforms and New Armed Services," *Issues in Science and Technology*, no 3, Spring 1985, quoted in Freedman "The Revolution in Strategic Affairs." 22.
[54] *LO2020* provides a clear if not somewhat similar notion of the "Dominant Maneuver" concept adopted by the United States and laid out in foundation documents such as *JV2010* and *Army Vision 2010*.
[55] Joint Vision 2010, 19.
[56] *LO2020*.
[57] *JV2010*., 20.
[58] Ibid., 20-21.
[59] Ibid., 21.
[60] Ibid., 22.
[61] Ibid., 24.
[62] Ibid., 25.
[63] Used in this sense to describe a dynamic inherent in analog C2 systems where through system inefficiency, friction etc, commanders are confronted with the chronic inability of a system to transmit information on time.
[64] The concept of the "empty battlefield" stems primarily from a increasing dispersion of troops driven by the enhanced lethality of weapons through technological innovation, most

notably the rifled musket, breech loading, the advent of the rifle magazine, smokeless powder and of course the machine gun. For an excellent reference, see; James J Schneider, "The Theory of the Empty Battlefield, " *JRUSI* (Sept. 1987).

[65] *Division XXI Advanced Warfighting Experiment* (DAWE) Final Report, U. S. Army TRADOC Analysis Center, Fort Leavenworth, Kansas, July 1998.

[66] This diagram (of which many variations exist) was obtained from a Combined Arms Center, Ft Leavenworth KS, briefing on doctrinal implications resulting from technological advancements.

[67] Ibid., 46.

[68] Ibid., 47.

[69] *LO2020* devotes a good portion of the study to many such technologies, and a good review is provided in, Thomas K Adams, "Radical Destabilizing Effects of New Technologies", Parameters, Autumn 1998., 99.

[70] Mike Brogan, LTC, US Army LNO to the French Signal School, notes provided by email, 14 April 1999.

[71] Ibid.

[72] Asynchronous Transfer Mode or ATM is a communications architecture that can simultaneously transmit, data, voice and video at speeds up to several hundred megabits per second.

[73] NATO uses standard symbols to denote unit size, and this works reasonably well. Terms are another story. Canada and the US, two very closely aligned NATO members have numerous term disconnects. For example, if you say RECON Troop to a Canadian he'll think platoon-sized organization where a US Officer will think company size. A squadron to a Canadian is a company-sized element, where as it is a battalion sized to an American. Two counterparts conversing can work through this, current machines can not.

[74] Collaborative planning tools such as white boards have been used with enthusiastic response in the US Army's AWE process. Simply, they allow multiple participants (a terminal at multiple command posts) to share a common map with graphic or sketch and collaborate interactively in real time.

[75] An automated course of action (COA) tool is one where a commander and his staff can input different options for a given mission, and derive outcomes based on parameters established in the system. This planning technique is traditionally done manually, often-consuming time and energy which are always in short supply. The obvious benefit is the speed with which this can be done and the variables, which can be introduced.

[76] George I. Seffers, "Common Database To Speed Battlefield Information., *Defense News*, April 5, 1999. .

[77] Michael R Womer Sr., FT Hood FBCB2 Senior Systems Engineer, TRW, INC. Notes provided via e-mail, 1 May 1999.

[78] Ibid.

[79] Jacques Hamel, LCOL Canadian Forces, interview by author, Kingston, Ont., 19 April 1999.

[80] Michael Clements, LTCOl, British Army LNO to U. S. Army Armor Center and FT Knox, notes provided via email, 27 April 1999.

[81] Ibid.

[82] Phillipe Kermovant, Colonel French Army, LNO to the U.S. Army Armor Center and FT Knox, KY., email notes, 07 April and 13 May 1999.
[83] Werner Gruhl, LTC German Army Liaison US Army Armor Center, FT Knox Kentucky, Briefing titled, "Digitization of the Battlefield, The German Army Approach" 25 August 1998, and notes provided via email April 20 1999.
[84] ATCCS program participants include; Belgium, Canada, Denmark, France, Germany, Italy, United Kingdom, Netherlands, Poland, Spain and the United States. The US Army contribution to this effort is entitled, Command And Control Systems Interoperability Program (C2SIP), and is a combined effort of the following agencies; Director of Information Systems for C4 (DISC4), Army Tactical Command and Control Systems (ATCCS) and TRADOC Program Integration Office, Army Battle Command System (TPIO ABCS).
[85] Multilateral Interoperability Program participants include; Canada, France, Germany, Italy, United Kingdom and the United States.
[86] The Battlefield Interoperability Program (BIP) was a multinational initiative/experiment, which successfully exchanged BIP message text using MTFs and AdatP format variants.
[87] Since 1996, Land Group 1 has been working on establishing standards for NATO members to communicate and exchange digital information with an objective of establishing a Level 5 shared database. There are numerous reports from various committees and working groups, however, key documents include: "LAND GROUP 1 ON INTEROPERABILITY OF COMMAND AND CONTROL INFORMATION SYSTEMS ON THE DIGITIZED BATTLEFIELD", AC/225(LG1)DS/5, AC/225(LG1)(INV) DS(98)2 both dated 11 September 1998, "NATO Policy For Interoperability" AC/321-N/28, dated 10 September 1998, "Deductions from the Land Group 1 Framework Paper" AC/225(LG1)D/8, dated 3 August, 1998. "Framework Paper on the Requirement for Combined/Joint Interoperability between C2 Systems supporting NATO Operations within the Land Componenet","AC/225(LG1)D/6, dated 2 March 1998.1`
[88] The term digital *deadspace* draws on the analogy of the term's common definition in that in combat operations the areas a direct fire system is unable to cover is labeled as "deadspace" and must be covered by other means usually mortars or artillery.
[89] In Dessert Storm, armored units moved great distances and at such a rate they often "out ran" the slower moving MSE vehicles, and operated out from under the grid of nodes required for the system to operate. See condition described in "Certain Victory".
[90] *Defense News.*, 1 March 1999., 2.
[91] "Cohen Worried About Technology Gap Between US and NATO Allies". *Inside the Pentagon*, March 4 , 1999., 5. Electronic version.
[92] Melvyn Krause *How NATO Weakens the West*, Simon and Schuster, New York, 1986.
[93] K. Steven Collier, Colonel US Army., "A REVIEW OF SELECTED TECHNOLOGIES AND ARMY AFTER NEXT.", US Army War College", (Carlisle Barracks, Penn, 1999): 26.
[94] Sean Naylor, "More Units Make the Cuts for Division XXI", *Army Times*, 4 January, 1999, 4.
[95] Sean Naylor, "Army unveils strike force blueprints", *Army Times*, March 1, 1999, 8.

[96] SIPRI, *SIPRI Yearbook 1998*, Armaments, Disarmament and International Security, Appendix 6B. Tables of NATO military expenditure, 236-237.

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